Evaluation Report of NIH K-12 Program

Title: Review of: National Institutes of Health Curriculum Supplements: Human Genetic Variation and Cell Biology and Cancer,

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Description:
This book review was published in the journal Cell Biology Education in the Fall 2004 issue. The reviewers were Karen E. Kalumuck of the Exploratorium Teacher Institute, and Kristina Doss of Carlmont High School in Belmont, CA. They found:

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Book Review

Review of: *National Institutes of Health Curriculum Supplements: Human Genetic Variation and Cell Biology and Cancer*, by Biological Sciences Curriculum Study and Videodiscovery; 1999; http://science.education.nih.gov/customers.nsf/highschool.htm

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The National Institutes of Health publishes a series of science curriculum supplements for K–12 education that are available from their Web site free of charge (http://science.education.nih.gov/supplements). In this feature, we review two of the high school supplements, *Human Genetic Variation* and *Cell Biology and Cancer*. Overall, we find that they are both excellent resources that engage students in learning science content while emphasizing the impact of scientific breakthroughs on personal and public health. In this review, we highlight the many strong features of the curricula and point out instances in which teachers may wish to seek out supplemental, updated information.

Keywords: secondary, curriculum, human genetics, cancer, cell biology, public health.

Whether or not high school students are inspired to become scientists, they are destined to be science consumers. They will be confronted daily with decisions ranging from choosing an effective sunscreen to deciding whether undergoing genetic testing is right for them or their family members. The recent, much-publicized explosion of scientific breakthroughs in the fields of human genetics and cancer research is rife with opportunities to engage students in considering the personal and societal ramifications of the discoveries. To discuss the issues intelligently, one must have a basic understanding of the science behind the breakthroughs.

Luckily for biology teachers, the National Institutes of Health (NIH) has developed an ongoing series of curriculum supplements for grades K–12 that combine basic science with applications to personal and public health. The curricula comply with the National Science Education Standards (National Research Council, 1996) and are free and available to download in their entirety from the Internet (http://science.education.nih.gov/supplements). Print copies of the curriculum including a CD-ROM can also be requested from the NIH Office of Science Education (6705 Rockledge Drive, Rm. 700, Bethesda, MD 20817-1814).

In this article, we review two of the high school supplements, *Human Genetic Variation* and *Cell Biology and Cancer*. We found that the materials attained the series' stated goals. Through inquiry, role-playing, and case studies, students learn basic scientific principles, develop an enhanced understanding of the nature of scientific practice, and gain insight into the relationship between basic science and personal and public health. Unlike many curricula, the emotionally engrossing nature of some of the material engages students while cementing information in their long-term memories.

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BACKGROUND

Each supplement contains five student activities, background and implementation material, a glossary, references, additional resources, and black-line masters for overhead transparencies and student handouts. The downloadable computer program includes video clips and animations. Each supplement opens with a section entitled "Introduction to the Module" that presents a historical overview of the topic and the concepts, with graphic summary, covered in the student activities. Because the activities are designed both to be taught to a group or studied independently, the summary provides a rapid means for teachers to select the most suitable activities for their needs.

Next are "Understanding" sections that provide scientific background. "Understanding Human Genetic Variation," for example, discusses why and how scientists study human genetics, how much variation exists and the significance of this variation, how our understanding of genetic variation affects medicine, and the ethical implications of this research to society. "Understanding Cancer" includes a history of advances in cancer research, the current molecular view of cancer, its human toll in terms of incidence and mortality rates, a discussion of treatment options, and the impact of cancer on society.

The "Understanding" sections are helpful and well written, with sufficient depth to enable teachers to become scientifically knowledgeable and familiar with the societal issues embedded in the topics. Teachers may choose to share the background with their students.

Ironically, the strength of these types of curricula, which focus on the rapid pace of scientific breakthroughs and their associated personal and societal ramifications, is also their greatest challenge. Both were published in 1999, and some of the background information is out of date. *Human Genetic Variation,* for example, was published before the human genome sequencing was complete. Information from the burgeoning fields of genomics, proteomics, and bioinformatics is absent. The statistics presented as "current" in *Cell Biology and Cancer* need refreshing. The latest citations of cancer incidence and survival rates are from 1991. Current data would reflect recent advances in cancer detection and treatment. To compensate, teachers will need to use some of their least abundant commodity—time—to gather current research and statistics.

"Implementing the Module" provides an overview of conceptual organization and flow of the activities. Tables correlate student activities with the National Science Education Standards (National Research Council, 1996) and chapters from 10 biology textbooks. Most of these books have new editions, and an updated correlation would be useful. Discussion of the "5-E" constructivist model of education and the organization of collaborative student groups is an unnecessary repetition of information that most teachers have learned during their credentialing process. Detailed instruction on using the CD-ROM (or the downloaded version of the program) is provided for both individual computers and networks. Most teachers will quickly address their needs by skimming the material or focusing on the graphic summaries.

The CD-ROM contains video clips and animations. In some clips, actors grapple with medical and ethical dilemmas or express opinions on public health legislation. Others show basic science images and videos. These segments enliven and personalize the material. Print alternatives to the CD-ROM are available on the Web site, but they lack illustrations that engage or illuminate. The CD-ROM includes an animation of the cell cycle and cell division, for example, but the print version includes only text.

ACTIVITIES

The activities contained in the modules range from science-based explorations to a discussion of ethical and societal issues. Debate and discussion of controversial issues that spring directly from biological research are an important aspect of class time. They encourage students to develop and voice their opinions about the societal consequences of biological research while learning science. Each of the activities includes components that attract students' attention and personalize the information

In *Human Genetic Variation*, "Alike but Not the Same" has students conduct an inventory of physical characteristics. In doing so, they document variation and gain familiarity with the interplay of multifactorial genetic traits with the environment. The interaction of genetics and environmental factors is personalized in the activity titled "Are You Susceptible?" By rolling dice, students see how choices they make throughout life could have an impact on their health and potentially lead to premature death.

On the CD-ROM, the section "The Meaning of Genetic Variation," which is an exploration of the molecular basis of sickle cell disease, includes a wonderful clip of blood cells sickling under low oxygen tension and becoming stuck in capillaries. Such exciting images usually are unavailable in classrooms. This activity did contain a serious error, however. The student materials describe the hemoglobin electrophoresis test used to diagnose sickle cell genetic status. As a challenge, students are asked to interpret a paper version of diagnostic test results from hypothetical patients. The paper test is keyed as a "DNA test," with "DNA alleles" run on a gel, but the students have learned about the protein test. The banding pattern of standards is inaccurate for hemoglobin, so this is not a mere typographical oversight. What should be a straightforward assessment of deductive skills becomes a source of confusion to students and teachers alike. It is surprising that this error was not caught, and disappointing that corrections have not been issued with the print or Web materials.

"Making Decisions in the Face of Uncertainty" tracks a family's anguished decision-making process and the consequences of being tested for the breast cancer gene. Students gain experience grappling with ethical dilemmas associated with testing (e.g., privacy issues). They see that science may tell us what we can and cannot do, but that what we "should" do is also informed by ethics and public policy.

In a similar fashion, the activities in *Cell Biology and Cancer* range from science content to ethical debate. "The Faces of Cancer" personalizes the disease by having students role-play individuals from a variety of backgrounds who develop cancer, connecting the roles of lifestyle and early detection to survival. "Cancer and the Cell Cycle" introduces students to the basics of a normal cell cycle and the fact that cancer results from genetic damage to normal regulatory controls.

The third activity includes one of the best uses of the CD-ROM in the two supplements. "Cancer as a Multistep Process" uses a "hit simulator." By changing variables in repeated trials and observing the graphic results for cancer rates in a hypothetical population, students deduce that the rate of accumulation of mutations directly affects the development of cancer.

Students explore the effects of ultraviolet radiation on mutation in "Evaluating Claims about Cancer." By designing, executing, and analyzing experiments of their own, students are immersed in scientific inquiry. Because the activity requires growing a particular strain of yeast, some teachers will not have sufficient resources to conduct this activity. Those unfamiliar with aseptic technique and streaking for isolation should seek advice from an experienced colleague. To provide a similar inquiry experience for students without access to the yeast cultures, an alternative could be suggested. For example, inexpensive, reusable, ultraviolet light-detecting beads that change color could be used to model the same experiments.

The final activity, "Acting on Information about Cancer," encourages students to debate their support or opposition to hypothetical legislation that would require children to wear protective clothing when outdoors. Using a reference database to search for information, students hone their critical thinking skills, reinforce their scientific knowledge, and see the impact and complexity that research can have on public

policy. The activity is intended to teach students to appreciate and value different points of view as well.

Both supplements are appropriate for a variety of high school biology classes, with the exception of advanced placement courses because of the severe time constraints on covering material that directly relates to the college board exam. The stand-alone feature of the activities is especially helpful. Teachers today are under extreme pressure to teach for accountability, as determined by a host of standardized tests, and to teach lessons that address the standards their school districts have adopted. Time may not allow them to include all of the activities, but they can easily select those that fit their needs. Skilled teachers of English language learners may modify activities to exclude some of the scientific vocabulary.

SUMMARY

When given the choice of print or Web versions of instructional materials, most teachers choose print versions. In theory, it is easy to download materials directly from the Internet, but it takes much more time to do the manipulations intrinsic to downloading than to open hard copies. Unfortunately, budget cuts have slowed fulfillment of print requests. One of us (Doss) requested print versions of these supplements over a year ago and has not yet received them.

These two NIH curriculum supplements are valuable free resources that can help teachers guide their students on the road to becoming informed consumers of science. Students learn scientific content, experience science as a process rather than a set of "facts," and see that the fruits of research affect them, their families, and their communities. Although these modules could benefit from updating, we enthusiastically recommend them both.

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REFERENCE

National Research Council.(1996). *National Science Education Standards*, Washington, DC: National Academy Press.